4.9 AVOIDED ENVIRONMENTAL IMPACTS AND IMPACTS ON URANIUM INDUSTRIES

This section discusses the potential avoided environmental impacts from the reactor alternatives for disposition, which have not been addressed in previous sections. Avoided environmental impacts of using MOX fuel instead of traditional uranium fuel in LWR power plants are discussed in Section 4.9.1. The potential impacts from the reactor alternatives on the uranium mining and nuclear fuel cycle industries are analyzed in Section 4.9.1.4. Section 4.9.2 discusses the avoided environmental impacts of using MOX fuel in LWR power plants instead of fossil fuel power plants in the generation of electricity.

The analysis presented in this section is based on the assumption that all of surplus Pu would be used as MOX fuel. For the Preferred Alternative, as a result of implementing a multiple technology disposition strategy, for analysis purposes, approximately 70 percent of the surplus Pu would be fabricated into MOX fuel and used in existing reactors. Subsequently, the avoided environmental impacts from the Preferred Alternative would be 70 percent of the respective avoided impacts presented in this section.

Potential avoided health impacts due to the use of MOX fuel in the CANDU reactors are not presented. Avoided health impacts beyond the U.S. borders are not required to be analyzed. If the CANDU reactors were selected as part of a multilateral agreement among Russia, Canada, and the United States, subsequent tiered NEPA review would be conducted.

4.9.1 USE OF MIXED OXIDE FUEL INSTEAD OF TRADITIONAL LOW-ENRICHED URANIUM FUEL IN NUCLEAR POWER PLANTS

For the Preferred Alternative, surplus Pu would be converted to MOX fuel for use in existing commercial nuclear power plants. In this alternative, part of the current nuclear fuel cycle in the existing commercial nuclear power plants would be replaced. In the United States, the uranium nuclear fuel cycle for commercial nuclear power plants is normally considered to begin with mining uranium ore and end with the disposal of the final radioactive wastes. The typical uranium fuel cycle for LWRs without spent fuel reprocessing in the United States is illustrated in Table 4.9.1–1. The MOX fuel cycle steps for proposed reactor alternatives are also listed in Table 4.9.1–1 for comparison. The pit disassembly/conversion process would replace the current uranium fuel cycle steps from uranium ore mining through uranium enrichment (steps 1 through 4 in Table 4.9.1–1). The nuclear fuel fabrication and burning in reactors would also be slightly different.

Table 4.9.1–1. Comparison of Uranium Fuel and Mixed Oxide Fuel Cycles

Step	Uranium Fuel Cycle	MOX Fuel Cycle
1	Uranium mining	Pit disassembly/conversion
2	Uranium milling	NA
3	Uranium conversion	NA
4	Uranium enrichment	NA
5	Uranium preparation and uranium fuel element fabrication	Uranium preparation and MOX fuel element fabrication
6	Nuclear power plants fueling–burning in the reactor	Nuclear power plants fueling–burning in the reactor
7	Spent fuel storage	Spent fuel storage

Note: NA=not applicable.

This section discusses the avoided environmental impacts of using the MOX fuel in existing LWRs. For the Existing LWR Alternative, the avoided environmental impacts would be due to the substitution of the MOX fuel for LEU (UO_2) fuel in LWRs. The existing LWRs are already in operation, and substitution of MOX fuel for uranium fuel may avoid some human health and environmental impacts.

4.9.1.1 Avoided Radiological Human Health Impacts

In the LWR uranium fuel cycle, contributors to the potential impacts on human health and the environment include uranium mining, uranium milling, and uranium conversion (from triuranic octaoxide [U_3O_8] to uranium hexafluoride [UF_6]). The other nuclear fuel cycle processes (enrichment plants, fuel fabrication plants) have considerably lower radioactive emissions than previous steps of the fuel cycle (mining, milling, and conversion). A summary of the atmospheric emissions of radioactive materials from the uranium fuel cycle and the MOX fuel cycle is shown in Table 4.9.1.1–1. Radioactive materials released into any liquid effluent are considerably less than the atmospheric emission and are not addressed.

By replacing the current uranium fuel cycle with MOX fuel, the uranium mining, milling, conversion, and enrichment are eliminated. As a result, the potential impacts to human health and the environment in the uranium fuel cycle process are reduced. Although the pit disassembly/conversion and MOX fuel fabrication processes create other impacts to the workers and public, the magnitude of these impacts are smaller than those of the uranium mining, milling, and conversion processes. Tables 4.9.1.1–2 and 4.9.1.1–3 compare the potential radiological impacts to the public and involved workers respectively, between the current fuel cycle process and the proposed MOX fuel cycle in existing LWRs.

For the general public within 80 km (50 mi), the expected latent cancer fatalities (LCFs) per year of operation would be 2.1×10^{-2} to 3.4×10^{-2} for the current uranium fuel cycle process and 2.7×10^{-5} to 1.4×10^{-2} for the proposed MOX fuel cycle burning in the two full MOX core existing LWRs. The avoided LCFs to the public then are 0.020 per year due to the substitution of MOX fuel for uranium fuel in LWRs. The total avoided LCFs for the public over the lifetime of the project (17 years) then would be 0.34, which represents the lower bounds of avoided health impact. For the Existing LWR Alternative, it would need three to five reactors that operate with the partial MOX core over their operating lifetime, which is equivalent to the two full core LWRs. Also the Preferred Alternative would dispose of the 70 percent of the surplus Pu in the existing reactors. Therefore, for the Preferred Alternative, the avoided impacts would be 0.24 LCFs for the general public.

For the involved workers, the expected LCFs per year of operation are 0.92 to 1.3 for the current uranium fuel cycle and 0.21 to 0.55 for the proposed MOX fuel cycle in existing LWRs. The avoided LCFs for the involved workers then are 0.75 per year due to the substitution of MOX fuel for uranium fuel in LWRs. The total avoided LCFs to the involved workers over the lifetime of the project (17 years) then are about 13. The Existing LWR Alternative would need three to five reactors that operate with the partial MOX core over their operating lifetime, which is equivalent to the two full core LWRs. For the Existing LWR Alternative, for analysis purposes, 70 percent of the surplus Pu was assumed to be used in existing LWRs. Therefore, for the Existing LWR Alternative, the avoided impacts would be 9.1 latent cancer fatalities for the involved workers.

[Text deleted.]

4.9.1.2 Avoided Air Quality Impacts

Ambient air quality can be affected by emissions of pollutants from the current fuel cycle process and the proposed Pu disposition facilities. The pollutants from the current fuel cycle come from the uranium mining, milling, conversion, and enrichment processes. The pollutant emissions are also from the fossil-fuel power plant that supply the electric power for the current uranium fuel cycle, mainly the uranium enrichment process. By replacing the current fuel cycle with MOX fuel, the uranium fuel enrichment process is eliminated. Thus, the fossil-fuel power that supplies the electric power to the uranium enrichment facility would not be needed. Table 4.9.1.2–1 compares the pollutant air emissions between proposed processes from Pit disassembly/conversion through MOX fuel fabrication and the fossil fuel power plant that supplies the electric power for the current uranium fuel cycle. The comparison shows that pollutant emissions from the current fuel cycle are higher than the potential emissions from the proposed MOX fuel fabrication process.

Table 4.9.1.1–1. Comparison of Radionuclide Atmosphere Emissions

Source	Principal Radionuclide	Emission Rate[a] (Ci/yr) Current Fuel Cycle[b]	Emission Rate[a] (Ci/yr) MOX Fuel Cycle
Uranium mines	Rn-222	1,200	NA
Uranium mills and mill tailing	Pb-210	$1.3x10^{-2}$	NA
	Po-210	$1.3x10^{-2}$	NA
	Rn-222	752	NA
	Ra-226	$1.3x10^{-2}$	NA
	Th-230	$1.4x10^{-2}$	NA
	U-234	$2.6x10^{-2}$	NA
	U-238	$2.6x10^{-2}$	NA
Uranium conversion	Ra-226	$1.7x10^{-6}$	NA
	Rn-222	0.23	NA
	Th-234	2.1x10-3	NA
	Pa-234m	$2.1x10^{-3}$	NA
	Th-230	$2.4x10^{-5}$	NA
	U-234	$2.1x10^{-3}$	NA
	U-235	$5.1x10^{-5}$	NA
	U-238	$2.1x10^{-3}$	NA
Uranium enrichment	Tc-99	$1.7x10^{-3}$	NA
	U-234	$5.0x10^{-3}$	NA
	U-235	$2.2x10^{-4}$	NA
	U-236	$9.2x10^{-6}$	NA
	U-238	$5.0x10^{-3}$	NA
Pit disassembly/conversion	Pu-238	NA	$4.2x10^{-7}$
	Pu-239	NA	$4.3x10^{-5}$
	Pu-240	NA	$1.0x10^{-5}$
	Pu-241	NA	$3.2x10^{-5}$
	Pu-242	NA	$2.9x10^{-10}$
	Am-241	NA	$1.7x10^{-5}$
Fuel fabrication	U-232	NA	$1.3x10^{-7}$
	U-234	$2.1x10^{-4}$	$3.2x10^{-8}$
	U-235	$7.1x10^{-6}$	$6.2x10^{-10}$
	U-236	$1.1x10^{-5}$	NA
	U-238	$2.7x10^{-5}$	$4.8x10^{-8}$
	Pu-238	NA	$7.9x10^{-7}$
	Pu-239	NA	$2.9x10^{-5}$
	Pu-240	NA	$7.6x10^{-6}$
	Pu-241	NA	$2.7x10^{-5}$
	Pu-242	NA	$1.1x10^{-9}$
	Am-241	NA	$1.4x10^{-7}$

Table 4.9.1.1–1. Comparison of Radionuclide Atmosphere Emissions—Continued

Source	Principal Radionuclide	Emission Rate[a] (Ci/yr) Current Fuel Cycle[b]	Emission Rate[a] (Ci/yr) MOX Fuel Cycle
Fuel fabrication (continued)	Th-231	$7.1x10^{-6}$	NA
	Th-234	$2.7x10^{-5}$	NA
	Pa-234	$2.7x10^{-5}$	NA

[a] The emissions are based on the assumption that two full MOX core equivalent large LWRs (about 2.0 GWe) are needed for Pu disposition. For the Existing LWR Alternative, it would need three to five existing LWRs. These three to five LWRs would operate with the partial or full MOX core over their operating lifetime, which is equivalent to the two full MOX core LWRs. For the Existing LWR Alternative, for analysis purposes, 70 percent of the surplus Pu was assumed to be used in existing LWRs. As a result, the campaign length would be reduced. However, since the comparison in this table is based on the annual emissions, it is independent of the number of years of operation for the Pu disposition.

[b] The radionuclide emissions given are for the model facilities. The emissions are adjusted according to the 2.0-GWe power output for two large LWRs (EPA 1979a; TTI 1996c).

Note: NA=not applicable.

Source: EPA 1979a; Table M.2.3.1–2.

Table 4.9.1.1–2. Comparison of Potential Radiological Human Health Impacts to the General Public

Fuel Cycle Process	Current Fuel Cycle[a]	MOX Fuel Cycle[a]
Uranium mining (LCF/yr)	$1.2x10^{-2}$	NA
Uranium milling (LCF/yr)	$8.0x10^{-3}$	NA
Uranium conversion (LCF/yr)	$4.6x10^{-4}$	NA
Pit disassembly/conversion[b] (LCF/yr)	NA	$1.5x10^{-7}$-$6.0x10^{-5}$
Fuel fabrication[c] (LCF/yr)	$2.0x10^{-5}$	$7.1x10^{-8}$-$2.4x10^{-5}$
Fuel burning in LWRs[d] (LCF/yr)	$2.0x10^{-5}$-$2.4x10^{-3}$	$2.2x10^{-5}$-$2.0x10^{-3}$
Total (LCF/yr)	$2.1x10^{-2}$-$2.3x10^{-2}$	$2.7x10^{-5}$-$2.1x10^{-3}$
Total (LCF/campaign[e])	0.36-0.39	0.00037-0.036

[a] Ranges of human health impacts in represent the health effects from different sites analyzed in the PEIS. No data for uranium enrichment are presented because of its minimal contribution to health impacts compared to other fuel cycle steps.

[b] See Table 4.3.1.9–1.

[c] See Table 4.3.5.1.9–1 for MOX Fuel Cycle. The LCFs for the current fuel cycle are adjusted for 2 large LWRs for consistency with risk estimators used in this PEIS (EPA 1979a; TTI 1996c).

[d] See Table 4.3.5.2.9–1.

[e] The impacts in this table are based on the assumption that two full core-equivalent large LWRs (about 2.0 GWE) are needed for Pu disposition in 17 years for all surplus Pu. For the Existing LWR Alternative, it would need three to five existing LWRs. These three to five LWRs would operate with the partial MOX core over their operating lifetime, which is equivalent to the two full-core LWRs. For the Existing LWR Alternative, for analysis purposes, 70 percent of the surplus Pu was assumed to be used in existing LWRs. As a result, the campaign length would be reduced.

Note: NA=not applicable.

Table 4.9.1.1–3. Comparison of Potential Radiological Human Health Impacts to Workers

Fuel Cycle Process	Current Fuel Cycle[a]	MOX Fuel Cycle[a]
Uranium mining (LCF/yr)	0.38	NA
Uranium milling (LCF/yr)	0.30	NA
Uranium conversion (LCF/yr)	0.0018	NA
Pit disassembly/conversion[b] (LCF/yr)	NA	0.034
Fuel fabrication[c] (LCF/yr)	0.10	0.012
Fuel burning in LWRs[d] (LCF/yr)	0.14-0.48	0.14-0.48
Total (LCF/yr)	0.92-1.3	0.19-0.53
Total (LCF/campaign)[e]	16-22	3.2-8.9

[a] Ranges of human health impacts represent the health effects from different sites analyzed in the PEIS. No data for uranium enrichment are presented because of its minimal contribution to health impacts compared to other fuel cycle stops.

[b] See Table 4.3.1.9–2.

[c] See Table 4.3.5.1.9–2 for MOX Fuel Cycle. The LCFs for the current fuel cycle are adjusted for 2 large LWRs for consistency with risk estimators used in this PEIS (NRC 1987d; TTI 1996c).

[d] See Table 4.3.5.2.9–2.

[e] The impacts in this table are based on the assumption that two full core-equivalent large LWRs (about 2.0 GWE) are needed for Pu disposition in 17 years for all surplus Pu. For the Existing LWR Alternative, it would need three to five existing LWRs. These three to five LWRs would operate with the partial MOX core over their operating lifetime, which is equivalent to the two full-core LWRs. For the Existing LWR Alternative, for analysis purposes, 70 percent of the surplus Pu was assumed to be used in existing LWRs. As a result, the campaign length would be reduced.

Note: NA=not applicable.

Table 4.9.1.2–1. Comparison of Potential Emission Rates of Criteria Pollutants

Pollutant	Current Fuel Cycle[a] (kg/yr)	MOX Fuel Cycle[b] (kg/yr)
Carbon monoxide (CO)	59,000	NA
Nitrogen dioxide (NO_2)	2,400,000	NA
Ozone (O_3)	NA	NA
Particulate matter (PM_{10})	2,300,000	NA
Sulfur dioxide (SO_2)	8,800,000	NA
Total suspended particulate (TSP)	NA	NA
Volatile organic compounds (VOC)	NA	2,500

[a] The emissions from a supporting coal power plant are derived from the NRC regulations (10 CFR 51 Table S-3). The original numbers in the NRC document are for 1-GWe LWRs. The numbers shown in the table are adjusted for 2-GWe LWRs.

[b] Emissions from the MOX fuel cycle are the sum of the emissions from pit disassembly/conversion and MOX fuel fabrication. See Tables F.1.3–4 and F.1.3–6. The MOX fuel burning in existing LWRs would not cause incremental pollutant air emissions over the current uranium fuel cycle. See Table F.1.3–12.

Note: NA=not available.

4.9.1.3 Other Avoided Environmental Impacts

In addition to reducing potential radiological human health and air quality impacts, fabricating the surplus weapons-usable Pu into MOX fuel for use in existing LWRs would cause other positive environmental impacts. The following positive impacts can be qualitatively stated:

- *Land Resources.* Reduced land disturbance from mining operations.
- *Water Resources.* Reduced impacts to water quality are expected since no mining and mill tailing would be produced, which allows surface runoff or leaching (mine drainage) to occur.

- *Waste Generation.* The total wastes generated by the MOX fueling process (including the pit disassembly/conversion, MOX fuel fabrication, and MOX fuel burning in existing LWRs) would be less than the total wastes generated by the uranium mining, milling, conversion, enrichment, fuel fabrication, and UO_2 fuel burning in existing LWRs.

4.9.1.4 Impacts on Uranium Mining and Nuclear Fuel Cycle Industries

Among the disposition alternatives evaluated in the PEIS, only the reactor alternatives (which would use MOX fuel instead of uranium fuel) could potentially affect the domestic nuclear fuel cycle industry. However, of the four reactor options evaluated in the PEIS (that is, using CANDU reactors, completing a partially built LWR, constructing a new evolutionary LWR, and use of existing LWRs), only using MOX fuel in the existing domestic LWR alternative would likely have any impact on the domestic nuclear fuel cycle industry. By using MOX fuel instead of fuel derived solely from LEU, this reactor alternative could potentially displace some demand for uranium feed products and services.

The CANDU Alternative would have no impact on U.S. uranium and nuclear fuel industries, because Canadian firms currently supply all of the nuclear fuel services and products required by that country's nuclear reactors. Canadian nuclear fuel is derived from Canadian uranium and is converted and fabricated by Canadian companies (CANDU reactors do not require enrichment services). Therefore, the only potential economic impacts would be to Canadian firms rather than U.S. producers. Producing MOX fuel would require significant quantities of depleted uranium, which comprises 97 to 98 percent of MOX feed material. However, the large DOE surplus inventory of depleted uranium would assure that this demand could be easily accommodated.[3]

The construction of an evolutionary LWR or the partially completed LWR could have some impact on the nuclear fuel cycle industries, although the magnitude of the impact would be highly uncertain. The impact from adding a new nuclear reactor as a source of electricity to the national power grid would depend on several factors, including whether:

- The new evolutionary LWR would be supplying power to meet new demand for electricity or supplanting supply from an existing reactor.

- The MOX-fueled plant would otherwise have been a uranium-fueled plant.

If the new power plant were to supplant existing commercial electricity supply from LWRs conventional uranium fuel, then it is possible that uranium demand could decrease. However, this scenario would be unlikely, because during the life cycle of any plant that would be brought on line, many of the currently operating nuclear power plants are expected to be retired. In fact, the EIA projects that between 1994 and 2015, nuclear power generation capacity will decline by 32 percent due to plant retirement. Furthermore, no new reactors are expected to come online before 2015. Electricity demand growth during this period is expected to be met through the construction of new fossil fuel plants, cogeneration, increased energy efficiency, and demand management. Therefore, it is unlikely that the construction of an evolutionary LWR or the completion of a partially built LWR would alter future demand for uranium, uranium enrichment services, or fuel fabrication from the No Action alternative.

The use of MOX fuel in existing domestic nuclear power plants would likely affect the demand for nuclear fuel services. Under this alternative, MOX fuel would be substituted for uranium fuel. If 2 to 3 t (2.2 to 3.3 tons) of Pu (93-percent enriched) per year were converted to MOX fuel and employed in nuclear reactors, approximately 730 to 1,100 t (805 to 1,213 tons) of U_3O_8 would be displaced per year. Because projections indicate that U.S. production of uranium fuel would only supply about 20 percent of domestic needs during the plant's life cycle (2004-2029), much of the impact projected on uranium fuel production would be borne by foreign producers.

[3] DOE is currently developing an EIS for the management of depleted UF_6

Based on current market shares, the MOX fuel could displace from 145 to 218 t/yr (160 to 240 tons/yr) of U.S. uranium oxide production. This compares to EIA projections that domestic uranium oxide production will reach approximately 4,000 t (4,409 tons) in 2005. Although the actual impacts would depend on the state of the uranium market during the nuclear power plant's lifetime, the use of MOX fuel should not have a significant impact on domestic production.

The impacts on uranium conversion, enrichment, and fabrication services would be similar to the impacts on the uranium mining and milling industries. The MOX fuel could displace a small percentage of these services, but the actual impacts are likely to be small. For example, the uranium conversion sector has recently experienced a much stronger market with large price increases over the past few years. This sector is projected to operate at almost full capacity into the foreseeable future. The impacts on the fabrication industry would likewise by small. The throughput rate of 51 to 73 t (56 to 80 tons) of heavy metal per year (depending on the type of reactor used), would represent less than one percent of current U.S. capacity.

It should be noted that the potential impacts described above would occur over the same timeframe as other DOE actions projected to affect the domestic uranium mining and nuclear fuel cycle industries. As, discussed in the HEU Final EIS, the disposition of U.S. surplus HEU and the purchase of Russian surplus HEU are projected to create only small and temporary economic impacts on the domestic uranium mining nuclear fuel cycle industries. Similarly, the sale of surplus natural and LEU currently stored at DOE's gaseous diffusion plants in Piketon, OH and Paducah, KY is expected to have minimal impact on these industries because of the small quantities and the protections provided by the *United States Enrichment Corporation Privatization Act* (DOE 1996s:4-33–4-36). The incremental impacts of using MOX fuel would be small, as would the cumulative impacts of these actions.

4.9.2 USE OF NUCLEAR POWER PLANTS INSTEAD OF FOSSIL FUEL POWER PLANTS

For the proposed Partially Completed and Evolutionary LWR Alternatives, the surplus Pu would be converted to MOX fuel for use in these power plants. Completing or building such nuclear power plants would create net environmental impact over existing conditions. The incremental environmental impacts from the Partially Completed LWR Alternative and the Evolutionary LWR Alternative have been analyzed and presented in Sections 4.3.5.3 and 4.3.5.4, respectively. This section discusses the potential avoided environmental impacts from these two alternatives.

According to the energy consumption projection for the next two decades, 252 gigawatts of new generating capacity will be needed between 1994 and 2015 to satisfy electricity demand and to replace retiring units (EIA 1996a:28). According to the same projection, new power plant constructions will be dominated by coal-fired and natural gas-fired power plants. Although the goal of all alternatives in the Pu disposition program is to dispose of the surplus weapon-usable Pu, the Partially Completed and Evolutionary LWR alternatives do generate electricity. If these alternatives are selected, the required new capacity for the coal-fired or natural gas-fired power plants could be reduced by the same capacity as the partially completed or evolutionary LWR using MOX fuel.

Comparing the coal-fired or natural gas-fired power plants, partially completed or evolutionary LWRs may have positive and negative impacts to the environment. Complete comparisons of the environmental impacts between the proposed partially completed or evolutionary LWRs and the coal-fired or natural gas-fired power plants are beyond the scope of this PEIS. The primary potential avoided impact for these alternatives is the impacts to ambient air quality in the area surrounding the facilities.

Ambient air quality can be affected by emissions of criteria pollutants from the coal-fired and natural gas-fired power plants, and the proposed Pu disposition facilities. More pollutant emissions from a facility poses more environmental impact. Table 4.9.2–1 compares the pollutant air emissions between the MOX fueling process using the partially completed LWR and the fossil fuel power plant that supplies the same amount of the electric power. The MOX fueling process using the Partially Completed LWR Alternative includes pit disassembly/conversion, MOX fuel fabrication, and MOX fuel burning. The comparison shows that almost all criteria pollutant emissions from the coal-fired power plants are much higher than the potential emissions from the proposed partially completed LWR with MOX fuel. Comparing the gas fired power plants, some of pollutants are emitted more from the proposed partially completed LWR using MOX fuel and some pollutants are emitted less. This comparison shows that the impact to the ambient air quality would be reduced if the surplus weapons-usable Pu is utilized as MOX fuel in the partially completed LWR to replace new construction of coal-fired power plants. However, it cannot be concluded that using MOX fuel in partially completed LWRs results in a positive environmental impact over the natural gas-fired power plants.[4]

Table 4.9.2–2 compares the pollutant air emissions between the proposed MOX fueling process using evolutionary LWRs and the fossil fuel power plant that supplies the same amount of the electric power. The MOX fueling process using the evolutionary LWR alternative includes pit disassembly/conversion, MOX fuel fabrication, and MOX fuel burning. The comparison shows that almost all criteria pollutant emissions from the coal-fired power plants are much higher than the potential emissions from evolutionary LWRs using MOX fuel. Comparing the gas-fired power plants, some pollutants are emitted more from evolutionary LWRs with MOX fuel and some pollutants are emitted less. This comparison shows that the impact to the ambient air quality would be reduced if the surplus weapons-usable Pu is utilized as fuel in the evolutionary LWRs to replace new construction of the coal and natural gas power plants.

[4] Use of the partially completed LWR or evolutionary LWR would create additional spent nuclear fuel.

Table 4.9.2–1. Comparison of Potential Emission Rates of Criteria Pollutants Between the Mixed Oxide Fuel Cycle Using Partially Completed Light Water Reactors and Conventional Power Plants

Pollutant	Coal Fired Plant[a] (kg/yr)	Natural Gas Fired Plant[b] (kg/yr)	MOX Fueled Nuclear Plant[c] (kg/yr)
Carbon monoxide	2,800,000	NA	81.6
Nitrogen dioxide	42,000,000	2,000,000	228,000
Ozone	NA	NA	NA
Particulate matter less than or equal to 10 microns in diameter	2,200,000	NA	17,500
Sulfur dioxide	42,000,000	24,000	171,000
Total suspended particulate	2,200,000	NA	17,500
Volatile organic compounds	NA	12,000[d]	2,500

[a] The original numbers in the NRC document are for a 1-GWe LWR (NRC 1987d: Table 17). The numbers shown in the table are adjusted for 2-GWe LWRs.

[b] The natural gas boiler is assumed to be the "controlled-flue gas recirculation" utility type, which has lowest air emissions listed in the EPA report (EPA 1995a).

[c] Emissions from the MOX fuel cycle are the sum of the emissions from the pit disassembly/conversion, MOX fuel fabrication, and the MOX fuel burning in the partially completed LWRs. See Tables F.1.3–4, F.1.3–6, and F.1.3–13.

[d] Organic compounds from the natural gas-fired power plant include methane that comprises 17 percent of organic compounds (EPA 1995a). The VOC value presented here assumes that methane is the only VOC among the organic compounds from the gas fire emissions.

Note: NA=not available.

Table 4.9.2–2. Comparison of Potential Emission Rates of Criteria Pollutants Between the Mixed Oxide Fuel Cycle Using Evolutionary Light Water Reactors and Conventional Power Plants

Pollutant	Coal Fired Plant[a] (kg/yr)	Natural Gas Fired Plant[b] (kg/yr)	MOX Fueled Nuclear Plant[c] (kg/yr)
Carbon monoxide	2,800,000	NA	90
Nitrogen dioxide	42,000,000	2,000,000	5,260
Ozone	NA	NA	NA
Particulate matter less than or equal to 10 microns in diameter	2,200,000	NA	NA
Sulfur dioxide	42,000,000	24,000	900
Total suspended particulate	2,200,000	NA	NA
Volatile organic compounds	NA	12,000[d]	2,500

[a] The original numbers in the NRC document are for a 1-GWe LWR (NRC 1987d, Table 17). The numbers shown in the table are adjusted for 2-GWe LWRs.

[b] The natural gas boiler is assumed to be the "controlled-flue gas recirculation" utility type, which has lowest air emissions listed in the EPA report (EPA 1995a).

[c] Emissions from the MOX fuel cycle are the sum of the emissions from the pit disassembly/conversion, MOX fuel fabrication, and the MOX fuel burning in the evolutionary LWRs. See Tables F.1.3–4, F.1.3–6, and F.1.3–14.

[d] Organic compounds from the natural gas-fired power plant include methane that comprises 17 percent of organic compounds (EPA 1995a). The VOC value presented here assumes that methane is the only VOC among the organic compounds from the gas fire emissions.

Note: NA=not available.